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# PREPARATION OF ZEOLITE CATALYST USING FLY ASH FOR CATALYTIC REDUCTION OF S. I ENGINE

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***ABSTRACT***

***In this paper we had prepared Zeolite from low cost coal fly ash. In this paper, Na-X Zeolite like component was manufactured from the fly ash remains of the coal. The present traditional three ways exhaust system utilized in fuel motors controls successfully the degrees of CO and HC yet it shows poor transformation in unsafe NOx outflow. The exhaust system is manufactured and the experimental tests are performed at the most extreme motor RPM to obtain threshold emission reduction value. The outcomes indicated the decrease of CO2 at a lower cost. Besides, it is discovered that utilizing Zeolite sieves can further decrease the toxin emanation at a comparative expense and utilizing glass wool to make a muffler for the exhaust.***

***KEYWORDS: Emission, Zeolite, Catalyst & Catalytic Reduction***

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Original Article

## INTRODUCTION

Zeolite based catalysts have pulled in much consideration because of their large movement and moderately Broad temperature variation window. The combination of new zeolites and comparative size specific solids and the presentation of reactant destinations into them is a standout amongst many well known regions of the research and in all respects as of late it finds significant probability in the manufacture of powerful exhaust system for vehicles, exhaust gases which are the real wellsprings of the present air contaminations.

Decrease of SI motor harmful discharge by utilizing X-zeolite like Catalyst was accomplished [1, 2]. [3] Announced that numerous zeolite based materials for the particular reactant decrease of NOx, with hydrocarbons. [4] announced the point by point consequences of particular NOx decrease over various zeolites [5] detailed the exercises of different particle traded zeolite-based impetuses (Fe, Mn, Co) under lean-consume motors. [6] Examined Iron Zeolite Catalysts for particular decrease of NO with the usage of NH3. [7] Inspected the difficulties in the improvement of new car catalyst that should come under profoundly requesting contamination decrease necessities.

Fly ash is mostly made out of certain oxides which are present in inorganic mixes that stay after ignition of the coal. The measures of the principle parts of ash viz., SiO2 and Al2O3, show couple of varieties with the sort of coal. The comparable substance synthesis of fly ash and some D. Karthikeyan, C. G. Saravanan volcanic rocks provoked a few research gatherings to endeavor making zeolite from fly ash when all is said in done, zeolite blend procedures include the expansion of a harsh operator to the fly ash slurry at comparatively higher range of temperatures. [8]Used fly ash as crude material for amalgamation of zeolite utilizing aqueous technique. From that

point onward, various specialists [9, 10, and 11] have utilized this procedure effectively, differing the aqueous temperature inside the scope of 333–573 K.

Furthermore, small parts of other metal oxides, for example, Fe2O3, MgO could likewise be utilized as viable impetus segments. He added that the Fly ash upheld impetuses have indicated great synergist exercises for deSOx, deNOx and hydrocracking that are equivalent to financially utilized impetuses. In light of the writing review, it very well may be inferred that soluble base combination pursued by aqueous treatment is the most solid technique for getting X-, Y-type zeolites specifically from fly ash of various arrangements that should be utilized as impetuses for some mechanically significant responses, by soluble base combination pursued by aqueous treatment. Modern business three-way exhaust system is comprised of cordierite.

## ZEOLITE

Zeolites are stable, unreactive, don't oxidize at high temp. , reusable, the following material was chosen as it is non toxic, easy to produce & completely harmless in nature [12]. Utilizing zeolites as catalyst have numerous points of interest since can be recuperated and reused without any difficulty and minimal effort, prompting less waste and less side-effects. The minimum temperature required to activate is 130◦C the key advantage of using that it alone can reduce all type of emissions such as co2, HC, NOx & have longer life of around 2 years. There are basically two forms of zeolite mentioned below.

### Fe-Zeolite

Fe-Zeolite is formed when FeCl3 is used instead of NaOH in the reaction, Regarding the reactant action and simplicity of impetus produce, Fe-zeolite impetuses join high N2O deterioration (and specific reactant decrease, SCR) movement with great hydro-warm solidness. Be that as it may, over-trade (FE/AL proportion = 1), that could be accomplished with the compound vapor affidavit strategy, yet which is additionally an objective in concentrates on WIE readiness, is anything but it is a factor in increasing high action. Wet particle trade an impetus under half of the trade locales involved by Fe.

### Cu-Zeolite

Cu- zeolites are formed when CuCl2 is treated instead of NaOH in the reaction, Cuzeolites are subordinates of the faujasite mineral gathering which thus it have different properties from the other zeolites. Cu-Y zeolites are manufactured through fluid or vaporous ionic trade not at all like the normally happening.

## COAL FLY ASH USED AS A CATALYST

Fly ash is one of the major waste by-products created from the combustion of coal, oil and bio-mass. Vast amounts of fly fiery remain is delivered in electric power plants all through the world consistently. Asset recuperation of fly ash created from coal-terminated power plants is a standout amongst the most vital issues of intensity plant squanders the executives. Fly powder has a mind boggling compound piece shaped chiefly from Silica ($SiO_2$), Alumina ($Al_2O_3$) and little measures of different oxides. As of late a few new methodologies have been taken to use fly fiery remains either to lessen the expense of transfer or to limit ecological effect. One of the methodologies is the change of fly fiery remains to zeolites which have numerous applications, for example, particle trade, atomic sifters, adsorbents and impetuses. A few papers demonstrated that different kinds of zeolites can be prepared with changing in the temperature.[13] Synthesized zeolite and Zeolite X and inspected the particle trade capacity (IEC)with Cobalt particle. The creator expressed that zeolite X has

a quicker $CO^{2+}$ion conversion standard as compared to zeolite A. [14] Changed over fly fiery debris to X type zeolite by soluble base combination pursued by hydro warm treatment. The creators contrasted the blended zeolite and business 13X zeolite and inferred that the physio-concoction properties of the two zeolites are practically same.[15] The incorporated zeolites are assessed for their capacity to adsorb sulfur-di-oxide ($SiO_2$) from an animated gas containing $SO_2$. Conclusions were made utilizing a spectrophotometer. The creators presumed that the incorporated zeolites adsorb $SO_2$ gas successfully.[16] The creator expressed that the sort and yield of blended zeolite emphatically rely upon soluble condition and silica-alumina piece of the fly fiery debris source. The creator further expressed that it is conceivable to orchestrate a particular zeolite by changing the silica-alumina mix. [17] Announced that it is conceivable to shape zeolites having more noteworthy $SiO_2/Al_2O_3$ mole proportion by including $SiO_2$ as Sodium silicate or different sources, for example, colloidal silica.

## DESIGN CONSIDERATIONS

### Selection of Catalyst

**Table 1: Selection of Catalyst**

| Properties | Platinum/Palladium | Activated Carbon | Hopocolite | Zeolite |
|---|---|---|---|---|
| Effectiveness(x2) | 18 | 14 | 16 | 18 |
| Cost(x2) | 12 | 18 | 16 | 16 |
| Selectivity | 8 | 8 | 8 | 9 |
| Method of Preparation | 8 | 9 | 7 | 8 |
| Life(x2) | 18 | 14 | 12 | 18 |
| Reactivation | 7 | 7 | 8 | 8 |
| Weighted Rank | 71 | 70 | 67 | 77 |
| Final Rank | 2 | 3 | 4 | 1 |

These are the factors which are taken into consideration while choosing the catalyst, Zelotile comes out to be as the best as it is economical has longer life, and Easy to prepare and Reactivation is easy.

### Manifold

SUS 430 was used as the outer pipe material [1] for fabrication of the pipe, keeping in mind its mechanical properties and heat resisting properties of larger cross sectional area for larger adsorption.

### Packaging

Packaging is done by using wire mesh and glass wool [4] in a Honey Comb pattern to provide maximum area for adsorption and maximum conversions and reduction of all harmful emissions.

## PREPARATION

The fly ash sample received was separated from dust and other particles by using a sieve (190 micron) so that the big pieces of the fly ash can be eliminated. Thereafter the fly ash was treated with Concentrated HCL so that the activity of the Zeolite Formation can be increased. After that the mixture which contains the HCl-treated fly ash was mixed in a proportion of 1:0.5:1 with NaOH solid powder and Sodium silicate nonahydrate ($Na_2SiO39H_2O$) powder. Grinding of the mixture have to be done after that the powder of the mixture was held into an aluminum tray and heated at 600°C in a heat chamber for about 45 minutes. Then the melded fly ash remain was filled a flask made up of glass in the continuation with the introduction of distilled water in a ratio of (10g /100ml). With continues stirring at constant room temperature the mixture was matured for 1 day. Then the mixture was continuously cured at 100°C constant temperature and at ambient pressure.

Then the remaining solid was washed out with distilled water in continuation with the vacuum filtration which is used to remove the excess sodium hydroxide and soluble impurities present in the solid mixture. Then the solid powder was dried at 90°C in air and constant temperature for the duration of 10 hours. The manufacturing process is shown below

**Figure 1: Heating at 600C for 6 hours**

**Figure 2: Mixing and Heating**

**Figure 3:Curing at 100C**

**Figure 4: Formation of Mesh**

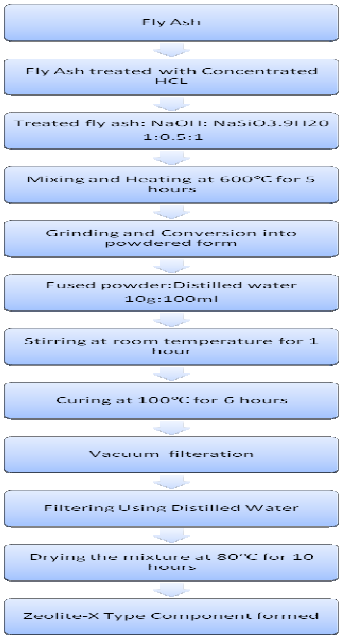


**Figure 5: Sequential Process Diagram**

## RESULTS

Volume Flow Rate = 32,940.5Lh-1

Catalyst Volume = 0.9 Litter

Catalyst Life = 1.5-2 Year

**Figure 6: Schematic of Emission Reduction System**

**Table 2: Comparison Tabular**

| | Without Reduction System | With Reduction System | Percentage Change |
|---|---|---|---|
| CO% | 1.045% | 0.830% | 20.575% |
| $CO_2$% | 1.830% | 3.82% | 108.743% |
| HC(ppm) | 629ppm | 56ppm | 90.621% |
| $O_2$% | 18.08% | 13.88% | 23.231% |

The reading is taken from a 305cc S. I Engine.

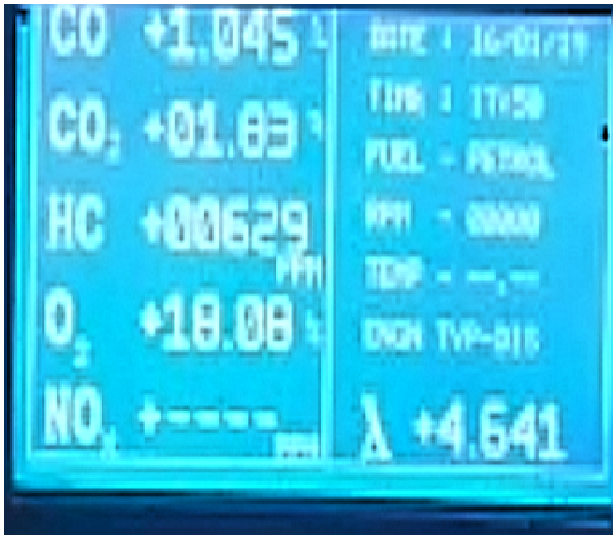


**Figure 7: Reading-1**


**Figure 8: Reading-2**

**Further Scopes**

- Bead structure-For larger surface area and less back pressure
- Honeycomb monolith structure-For Compact shape and maximum efficiency

**Additives**

To increase NOx conversion efficiency following additives can be added-

- Fe-zeolite –Prepared by ion exchange with FeCl3.
- Cu-zeolite -Prepared by ion exchange with CuCl2.

## CONCLUSIONS

With the number of conventional vehicles (running on fossil fuels) being driven increasing at astonishing rates, pollution levels in urban cities have reached a point where breathing polluted air can lead to several life threatening diseases. Therefore, Zeolite is a suitable solution as it fulfills the following factors:

- Catalytic is cost effective
- Chemicals used during synthesis is eco-friendly
- Catalyst is multi-purpose as it reduces CO, HC and NOx (Theoritacally)
- Easy to make
- Highly efficient

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